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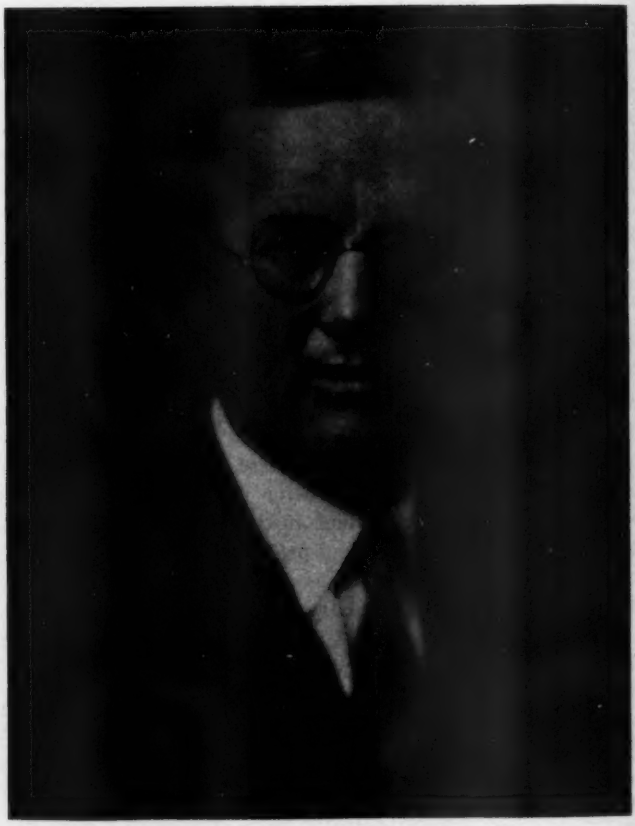
PRESIDENT O. M. LELAND.

Ora Miner Leland, Dean of the College of Engineering and Architecture and the School of Chemistry at the University of Minnesota was born at Grand Haven, Michigan, June 28, 1876. His family is of English descent and his ancestry in New England dates back to 1652.

After the usual public school education, he graduated in civil engineering from the University of Michigan in 1900. As a result of graduate study, he received the professional degree of Civil Engineer from the same institution.

A large part of his professional service has been with the United States Government, beginning in 1898 in the General Land Office in Florida. He later entered the Coast and Geodetic Survey and saw field service in various parts of the United States, Alaska, and Porto Rico, besides office experience in Washington. In 1903, he entered the field of engineering education as an instructor in civil engineering at Cornell University, with which institution he was connected in various capacities, including professor and head of department, until 1920, when he accepted the deanship of two separate colleges at the University of Minnesota.

During his teaching career, at times on leave of absence, Dean Leland engaged quite extensively in professional practice. For seven years, he had charge of the location and demarcation of various sections of the international boundary between Alaska and Canada, conducting field parties in Alaska in the summer, and office work during the winter. For two years, he was a member of the Costa Rica-Panama Arbitration Commission, being one of the two non-partisan members appointed by the Chief Justice of the United States Supreme Court, his colleague on this work being the late Dean John F. Hayford, of Northwestern University, a former president of this Society. In 1920, he served as engineering



PRESIDENT ORA MINER LELAND

supervisor with the J. G. White Engineering Corporation in New York City.

Before the entry of the United States into the World War, Dean Leland had been commissioned in the Engineer Officers' Reserve Corps. He served from April, 1917, to June, 1919, holding the rank of Lieutenant-Colonel of Engineers and Division Engineer with the 303d Engineer Regiment of the 78th Division in France and with the 314th Engineers of the 89th Division in Germany and Belgium. His service included participation in the St. Mihiel and Argonne-Meuse offenses by the American Army. At present, he is colonel of the 313th Engineers (Combat) of the 88th Division of the Organized Reserve.

In addition to many articles in the engineering and educational press, Dean Leland is the author of a book entitled "Practical Least Squares." He is a member of the American Society of Civil Engineers, the American Association of Engineers, the Society of American Military Engineers, the Engineers' Club of Minneapolis, and the American Astronomical Society, besides local societies and clubs. He is a fellow of the American Association for the Advancement of Science, and a member of Sigma Xi, Tau Beta Pi, Chi Epsilon, and Triangle.

SPECIFICATIONS FOR PROCEDURE IN UNDERGRADUATE TEACHING IN THE DEPARTMENT OF CIVIL ENGINEERING AT THE UNIVERSITY OF ————.

BY C. C. WILLIAMS,

Dean of the College of Applied Science, University of Iowa.

PREFATORY NOTE.

The purposes of these "specifications" are (*a*) to aid the less experienced members of the staff in selecting an approved procedure in conducting classes and (*b*) to promote uniformity of practice with a view to economy of effort on the part of both teacher and student. No attempt has been made to specify methods of teaching in detail, for each instructor must devise his own methods to a considerable extent.

These specifications are analogous to those prepared by a chief engineer (perhaps in collaboration with his staff) for the guidance of his subordinates in the execution of engineering works. They will not insure good results unless intelligently applied.

DEFINITION AND PURPOSE.

Definition.—Teaching shall be broadly defined to include all official contacts between instructor and students required by the University, either formally by assignment or informally by circumstances, together with the departmental administration of the same. It thus includes departmental staff meetings and committee work, conferences with students, and appearance on student society programs upon invitation.

Purpose.—The purpose of teaching in the civil engineering department shall be to educate men for the practice of civil engineering. To this end, the teaching shall aim at the following objectives, keeping always in mind that "educating" implies developing the faculties of the individual student rather than molding all to a uniform pattern:

I. To train the student to think clearly and to express his thoughts with facility and precision, using the principles of civil engineering as exercises.

This training involves (*a*) instilling orderly and direct mental habits, (*b*) strengthening the discipline of concentration, (*c*) establishing criteria of validity and of completeness, (*d*) acquiring power and discernment in analysis, (*e*) chastening the judgment and grasp in synthesis, and (*f*) developing ability in both written and spoken discourse.

II. To impart a modicum of information concerning the fundamental facts, principles and practice of civil engineering and to acquaint the student with the important sources of such information.

III. To reveal the student's powers and deficiencies to him and to direct him in developing the former and in overcoming the latter.

IV. To give the student an understanding of the political and economic organization of society so that he may advantageously adjust himself and his calling to his environment.

V. To stimulate on the part of the student the desire to progress and the will to achieve.

VI. To foster character and inculcate the ideals of good citizenship, impressing service as the consummation of the profession.

VII. To cultivate grace in social intercourse and such other personal qualities as inspire confidence and esteem.

VIII. To encourage the student to seek such a breadth of knowledge and of sympathies as will refine his enjoyment and enrich his experiences.

Instruction by Formal Class Meetings.

Incidental and Inferential Instruction.—The instructor shall devote the time of the class meeting to considering the subject matter of the course, and rarely, if at all, indulge in harangues of a general character, realizing that character training is chiefly by inference from conduct and by practice rather than by precept.

The instructor shall be a "salesman" of his course, giving attention to convincing the student of its value and enlisting his desire to secure its benefits.

He shall hold before the class a proper point of view with regard to his course, indicating its relations to the remainder of the curriculum and to the practice of the profession.

He shall endeavor to teach efficient modes of study on the part of the student and be constantly on the alert to correct slovenly mental habits.

The instructor shall use his best English in speaking before his classes in order that the student may be accustomed to accurate expression of technical matters. Slang, whose use generally indicates poverty of vocabulary and militates against conciseness in thinking, is subversive of best results in teaching and is, therefore, disapproved. Coarse speech and profanity in class room are not permissible.

In all exercises, the instructor shall strive to secure maximum efficiency in the use of the student's time, the instructor's own convenience being secondary.

The instructor shall adopt a spirit of intellectual honesty in his conduct of class work, meeting the exigencies of the class room with candor and sincerity. In the event that he is required to discuss a matter concerning which he is uncertain as to the completeness of his information, he shall frankly indicate the degree of reliability which he believes should be attached to his remarks.

He shall conduct all class exercises so as to habituate the students to orderliness, industry, self-reliance, perseverance, punctuality and intellectual honesty, recognizing these as the expected normal characteristics and penalizing contrary traits.

He shall encourage the spirit of inquiry concerning the subject matter of the course and resourcefulness in devising new procedures in performing class exercises.

Preparation for Class.—Before the end of the first week, the instructor shall prepare a complete program of the semester's work, with scheduled dates (approximate if exact dating is impracticable) for the completion of the various

major portions of the same. This program shall include all supplementary references regularly used.

Previous to the meeting of each class, the instructor shall prepare himself specifically on the subject matter of the class assignment and plan the program for conducting the class. He shall so prepare himself as to be ready to supplement, amplify, or illustrate each part of the lesson assignment.

The program and the methods of conducting class shall be designed (*a*) to fix in the student's mind a comprehensive outline or skeleton-framework of the entire subject as covered in class and (*b*) to expand this with such details and other pertinent matter as the time available will permit, maintaining a consistent balance and proportion with regard to the character of the material included.

The instructor shall follow a systematic program of self-advancement beyond the range of class study in the subject taught. Where there is a student of exceptional mental calibre in the course, the instructor shall endeavor to enlist the interest of such superior student in his own advance work with a view to activating this student's latent initiative and encouraging him to delve into any aspect of the subject that may attract him.

General Class Procedure.—The instructor shall be in the class room ready to begin the class exercise before the ringing of the opening gong.

He shall call the roll of the class immediately at the ringing of the opening gong, and shall dismiss promptly at the ringing of the closing gong.

The instructor's criticisms of the student's efforts shall be free from sarcasm and ridicule, and shall be made sincerely and sympathetically.

All formal written exercises required to be submitted shall be graded and returned to the student as soon as practicable. The instructor shall indicate on the paper the portions which are unsatisfactory, and his criticisms shall cover both content and form.

Proper class decorum shall be insisted upon. Boisterousness and inattention to duty shall not be tolerated.

Lectures.—In general, teaching by formal lectures for a considerable portion of the course is not approved, although lectures may properly be employed for giving perspective in approaching a subject or a division of a subject. Summarizing lectures, having but little pedagogic value are not sanctioned; all summarizing should be done by the student.

Where lectures are employed, particular care shall be exercised in fixing the scope of each lecture so that it may cover a definite portion of the subject.

Recitation-Discussion.—Except in such classes as design, field and laboratory, classes shall normally be conducted by the recitation-discussion method.

Ordinarily, a textbook with regular assignments therein shall constitute the basis for recitation-discussion classes.

Immediately after roll-call, the instructor shall assign the next lesson, taking whatever time may be required to make the assignment properly. In making the assignment, he shall endeavor to give the student an intelligent approach to the subject matter involved and to stimulate his interest in the same.

The length of the assignment shall be gauged so as not to require for its preparation more time on the part of the average student than has been allotted to this subject in the curriculum. In so far as practicable, each assignment shall constitute a definite theme, or portion of the subject.

The class period shall consist essentially of exercises in thinking, expression and testing rather than imparting information.

In conducting the recitation, the instructor shall vary the type of questions asked: *e.g.* (*a*) using topical questions to ascertain the student's grasp of the general relationships involved; (*b*) interrogating searchingly and systematically by a series of questions on one topic to reveal the degree of thoroughness of preparation; (*c*) quizzing rapidly and skipping about to arouse interest; (*d*) asking applicatory questions which involve estimates and conjectures to test and develop judgment and sense of proportion on the part of the student;

(*e*) proposing questions involving error to test the student's alertness in detecting it and his self-confidence in exposing it; (*f*) setting tasks for the entire class to be finished competitively to develop speed; (*g*) setting up cases for extended analysis and discussion; (*h*) requiring a homely illustration or simplified application of the matter involved in the discussion; (*i*) requesting a general summary to be given by the student at the close of the discussion; (*j*) having a written recitation by the entire class on one or more topics; (*k*) calling for an extended discussion of a topic, the student standing before the class during its delivery.

Completeness of statements on the part of students in recitation shall be insisted upon, and vague, fragmentary and partial statements discouraged.

The instructor shall generally pass judgment on a student's recitation when the latter is particularly meritorious or especially lacking in logic or relevancy. (Commendation, where merited, encourages students to strive for excellence.)

The instructor shall require some form of report on all required supplementary reading. He may well recommend additional supplementary reading for the superior students who have time to do the same.

Written exercises, including problems, abstracts, briefs and outlines, being effective devices in improving grasp and concentration, shall be used in proper proportion in class exercises.

In general, the instructor shall stand rather than sit while conducting a recitation-discussion class.

Design Classes.—Design classes are intended primarily to train students in the application of principles learned from textbooks, and in the development of coordination and judgment.

All exercises for design classes shall be carefully planned to secure desired results most efficiently.

Design exercises shall be formulated to contemplate the adequacy of the structure as to function and stability, its relative economy and its appearance, as well as to proportion the parts and draft the details.

The instructor shall formulate a time schedule for completing the class exercises based on the ability of the average student, which he will post in the drafting room.

The instructor shall check designs not only as to draftsmanship, but as to accuracy as well and he should plan the exercises so as to facilitate such checking.

The instructor shall scrutinize the student's methods in making calculations in order that the student may acquire efficient procedure.

The instructor shall, in general, remain in the drafting room and devote his attention to the class during the entire class period.

Each student shall have an assigned place of working. If the student desires to leave the room for any purpose, he shall deposit a "time out" slip in the receptacle provided, on which he shall note the occasion for his leaving, the time of leaving and the time of return. Students who are absent unduly from their places shall be required to work extra time in order not to lower the average progress of the class.

Any equipment assigned temporarily to a student shall be recorded by number so that responsibility for the same may be determined.

Laboratory Classes.—The purpose of laboratory exercises is to train students to observe, record and interpret phenomena pertaining to materials, processes and performance, and to aid in understanding the textbook statements concerning the same.

Printed instructions for laboratory exercises shall be made available to the student and these shall include forms for recording observations.

Apparatus for the laboratory exercise shall be placed in readiness previous to the class meeting.

The written report of the exercise shall contain, in addition to the recorded observations and their reduction, an interpretation of their significance as affecting practical engineering. Extended description of apparatus and of procedure shall not be required. Honesty and self reliance in making observations and in reporting shall be considered paramount.

Surveying Field Classes.—The purpose of the surveying field work is to train the student to make surveys, record notes and make maps, primarily with a view to the location and design of a subsequent engineering project.

The instructions shall cover technique of procedure as well as theory, of surveying, and good technique shall be insisted upon.

Field notes shall be collected and criticised periodically by the instructor, with regard to both form and content.

The exercises shall be planned so that the instructor can determine the correctness of the student's results, which shall be scrutinized by the instructor, as well as the form of procedure.

The instructor shall remain in the field and devote his time to instruction during the class period.

Examinations.

General.—Examinations comprise semester quizzes, final examinations and special examinations, each serving its peculiar purposes.

Examinations may be given with the text or without at the discretion of the instructor. All examinations shall be properly proctored.

Questions designed to test memory and accuracy of information shall pertain to material of fundamental importance in the subject which has been duly emphasized in class discussion.

Questions pertaining to theory shall be designed to test the student's power and efficiency of thinking rather than his memory. To this end, questions may well be framed to involve applications of principles and facts rather than their mere statement.

Examination questions shall be carefully prepared and reviewed before being used. All problems for examinations shall be solved by the instructor from the prepared question sheet previous to the examination period.

In grading the answer to an examination question on the

basis of 10, the following scale shall be used as nearly as practicable:

Correct, complete and well stated answer	10
Minimum competent answer, involving slight inaccuracy or incompleteness	7–9
Correct theory but serious error in application	5–6
Partly erroneous theory but approximately correct result, indicating good judgment	3–4
Commendable trial but entirely wrong	1–2
Practically no trial	0

A copy of all examination questions shall be filed with the head of the department at the time the examination is given.

Semester Quizzes.—The purposes of the semester quiz are: (*a*) to stimulate a review of the matter covered, (*b*) to disclose to the student the adequacy of his preparation, and (*c*) to test the student's knowledge of the subject at that time in order to judge of his rate of progress and to aid in determining the semester grade for the course.

The number of semester quizzes shall preferably be three for five hour courses and corresponding fewer for briefer courses.

In general, no quiz shall be given without at least one day's notice to the class, since the preparatory review constitutes a large part of the value of the quiz.

Final Examinations.—The purposes of the final examination are: (*a*) to test the student's knowledge as a part basis for determining the semester grade, (*b*) to stimulate a comprehensive review, and (*c*) to train the student to work efficiently under stress.

Final examinations, being a part of the semester's instruction, shall be given in all subjects, except by special provision otherwise.

The questions shall not be ambiguous and they shall be capable of determinate grading. Specific interrogatories rather than unqualified requests for general discussion or for an essay on a given theme shall, in general, be used.

Special Examinations.—The purpose of special examinations is to test the student's knowledge and power in the subject with a view to determining his credit in that subject.

Since credit depends entirely upon the special examination, the latter shall be more searching and comprehensive than an ordinary final examination, and a correspondingly longer period shall be allowed for the writing.

Special examinations shall be given only after the instructor and the head of the department are convinced that the student has made such preparation that there is a fair probability of his successfully passing.

Semester Grade.—The semester grade is used to determine the scholastic ranking of the student for various purposes and ultimately, his candidacy for a degree.

The semester grade shall be based on all of the work of the semester. All formal written work shall be graded and shall contribute in proper proportion to the final grade.

The basis of grading in recitation-discussion courses shall be approximately as follows:

Class work	30 per cent
Semester quizzes	30 " "
Final examination	40 " "

In design, laboratory and field classes, the basis of grading shall be approximately:

Class exercises	60 per cent
Final examination	40 " "

At the close of the school year, all class record books shall be filed in the office of the head of the department.

Instruction by Conferences.

Instructors shall ordinarily be at their offices during university hours, except when otherwise engaged in university duties, in order that they may be available for student or departmental conferences.

Instructors shall arrange and post their office hours when students may confer with them about their subjects.

Where a student in a course displays decidedly superior mental powers, the instructor shall endeavor through private conference to assay such abilities and to encourage the student to profit in proportion to his ability by exploring the course on a widened scope and an intensified scale.

Through private conferences, the instructor shall seek to know his students more intimately than is possible from classroom contacts, with a view to understanding the attitudes and performances of the students.

Teaching Load.

The teaching load of an instructor who is devoting full time to instruction (none to research, general university administration, public service, etc.) shall be determined roughly by the following formula, if the classes are of normal size:

$$R + 2.5D + 3L = 15$$

R = number of credit hours of recitation classes,
D = number of credit hours of design classes (3 hour periods),
L = number of credit hours of laboratory and field classes (3 hour periods),
N = number of students in a normal section,
N' = number of students in the section considered.

If a class is not of normal size, the credit hours for that subject shall be weighted by the factor $(2 + N'/N)/3$.

Additional sections of a course taught by the same instructor shall be given a weight of two thirds the first section in constituting the teaching load of that instructor.

In general, not more than three different subjects shall be included in the teaching load of an instructor for one semester.

An instructor who is formally assigned to research, graduate teaching, general administrative duties, special care of equipment, public service, or similar duties, shall have his teaching load correspondingly reduced.

SOME QUESTIONS ON THE COURSE IN MECHANICS.

A. P. POORMAN,

Chairman, Committee on Mechanics.

The newly appointed committee on Mechanics is undertaking the study of several fundamental questions in regard to the teaching of their subject. In this brief article, several of these questions will be stated and discussed, not with the idea that what we say is final, but with the hope that further clarifying discussion may be obtained. Comment from any readers who have had experience in teaching Mechanics or any similar subject will be welcomed by the committee.

1. *How much time should be given to the study of Mechanics?* In this question, the term "Mechanics" is intended to include only the class-room work in Statics, Kinetics and Strength of Materials. Since the principles of Mechanics form the foundation of such a large part of all engineering, it is essential that sufficient time be given to it to permit a mastery of the elementary principles of the subject and the development of the ability to solve simple problems quickly and accurately. It is the writer's opinion that such mastery can not usually be attained in less than about 140 periods of one hour each. With the 18-week semester, four hours per week for two semesters will give approximately this length of time. An arrangement of five hours per week for one semester for Statics and Kinetics, and three hours per week for the other semester for Strength of Materials may be more satisfactory if teaching loads can be equalized.

If for any reason it is necessary to shorten the time, the instructor is confronted with the delicate task of selecting the portions which may be omitted with the least detriment to the course. If more time than this is available, a few of the subjects commonly left for Advanced Mechanics may be included, but it is felt that extra drill on fundamental problems will yield better results.

2. *How much written work to be graded should be required, and what should be its type?*

Written work required of students in Mechanics should be planned with two things in mind. First, it is essential that the student make proper preparation of the work assigned for the day's lesson, and second, it is necessary that the instructor obtain some accurate record of the student's performance. One method is to assign certain problems, usually one for each period, which are to be worked out on paper at home and handed in. This method has some advantages, but more disadvantages. It furnishes a definite assigned task which gives incentive to the study of the theory in order that the method of solution of the problem may be understood. Very often, however, the student spends the greater part of his study time on the one problem and feels that when he has solved it he has his lesson prepared. It is usually difficult to include enough in one problem to give sufficient drill on the entire lesson. It has been the writer's experience that very often some students will not work the problems but will copy them from the work of others. The grade on such work therefore means little.

Another method, when blackboard space is available, is to assign problems to be worked at the blackboard during the recitation hour. This method has more advantages than the one just mentioned, but also has some disadvantages. The psychological effect of taking a piece of crayon and working at a problem is very good. Any mistake is easily erased, the instructor is at hand to give any needed assistance and the buzz of industry from the other students is invigorating. On the other hand, if the same problem is assigned to all of the men, there is great danger of help being given, especially if the work is to be graded. If this method is used, different problems should be given to men standing side by side. If such work is to be given a grade and the room is to be occupied the following period, the instructor very often finds it difficult or impossible to examine each solution with proper care. The student does not have the opportunity to examine his work later, to note the errors if such have been made. If the in-

structor, in his haste to give grades to all of the work, should chance to overlook something, the student has no redress. In many cases, lack of adequate blackboard space makes this method impracticable.

For a number of years, all of the members of the Mechanics department here at Purdue have used the following plan of recitation, with excellent results. The class recitation period is 50 minutes long and classes consist of 15 to 20 men. The time for the first thirty or thirty-five minutes is used in answering questions regarding theory or derivations, or in solving problems on the blackboard about which some student has raised a question. In all of this, the instructor is continually calling on first one and then another, to suggest procedure, to designate the "free body" to be used, to enumerate the forces on the free body, to state the equations to be used in the solution and to give slide rule results of the necessary computations. If alternative methods are possible, some student may be asked to state his preference and to give reasons for it. No attempt is made to grade students on these oral recitations, on account of the difficulty of giving proper weight to different answers.

After this period of discussion, half sheets of paper are passed out and a problem is assigned to be worked out and handed in. It may be one of the problems in the day's assignment, with possibly some item of data changed, or it may be a new problem of the same type as those discussed. The student is permitted to refer to his book or note book if he so desires, but help from one student to another is not permitted. If there are enough seats in the class room, men are seated with one or two seats between them and all are assigned the same problem. If seats are too few to permit this, two different problems are assigned, one to the men in the odd-numbered rows, the other to those in the even-numbered rows. At the end of the period, these papers are collected and graded. If there are mistakes they are indicated and the papers are handed back to the students at the next period. Having the paper back with mistakes marked and problem graded gives the student a feeling that the instructor is playing fair.

About every two weeks a test is given covering all of the work since the last test, and occupying the entire period. During the tests, no reference to text or note book is permitted. These tests are also graded, errors marked, and papers are handed back at the next period. At the end of the semester a three-hour final examination is given, likewise under test conditions. These are graded and may be examined by the student, but are retained by the instructor.

During a semester, about 40 daily recitation grades and 7 test grades are obtained. The average of the 40 daily grades, the average of the 7 test grades, and the final examination grade count equally in determining the student's semester grade.

It has been found that the certainty that a problem will be required at the end of the period is a great incentive to make the student prepare his lesson thoroughly each day, and also to pay close attention to class room discussion. In securing these two ends, it is felt that the plan has proved its value.

ON THE MEANING OF CENTRIFUGAL FORCE.

M. M. FROCHT,

Assistant Professor of Mechanics, Carnegie Institute of Technology.

Though Aristotle was on the verge of discovering centrifugal force, the laws governing it were destined to remain a mystery for nearly 2000 years after his death. It was left to Huygens to be the first to understand, and to state the theorems concerning this force, which he did in 1673 in his Horoglium Oscillatorium.

In our modern classrooms we quite naturally present the subject matter of mechanics without regard to historical sequence. Being anxious to explain a large number of rotational phenomena we introduce the concept of centrifugal force at the beginning of the study of physics. In this process of premature explanation a very important principle of mechanics is unintentionally injected: the principle of D'Alembert. This principle is, unfortunately, not as well understood or known as it should be. The unintentional fusion of this principle with the concept of centrifugal force results in a confused and unreal picture, not only of centrifugal force, but of forces in general.

It is the object of this paper to show that the point of view developed in these premature explanations, a point of view which looks upon centrifugal force as an *external* force really acting on a body in rotation is erroneous, and to show the real meaning of this force in the light of D'Alembert's principle. Incidentally, a fundamental proposition will be developed, which apart from its contribution to its present discussion will be found useful in connection with free-body diagrams.

A few general remarks about forces will now be made.

On Forces.—A force may be defined by its universal property, which consists of always causing acceleration in the body on which it acts, and by the further property of being

the only cause of acceleration. This definition is sometimes modified to say that a force causes, *or tends to cause* acceleration. This modification, which is supposed to take care of the case of equilibrium is to my mind, unnecessary and confusing. A force does not lose or change its essential character of giving birth to acceleration when it acts on a body in equilibrium. No such change is stated or implied in Newton's laws. Even under conditions of statics this property is preserved. The above modification loses sight of the fact that what we usually observe is not the acceleration of one particular force, but the resultant acceleration of all the forces which may be acting upon a body. In the case of equilibrium this resultant is zero. But this would hardly justify us in saying that any particular force has changed its fundamental character of activity to one of mere tendency. We might as well say that only in the case of a force acting by itself does it cause an acceleration in the direction in which it acts, but when a force acts in conjunction with other forces it changes this property and merely tends to do so, for obviously what we observe is an acceleration in a direction totally different from any of the forces. It is clearer and truer to speak of a force as having the property of causing *always*, whether acting by itself or in conjunction with other forces, in case of equilibrium or in case of dynamics, its own distinct acceleration in accordance with Newton's second law.

On Action and Reaction.—Newton's third law teaches that forces occur in pairs of equal and opposites. For every force in the universe there is somewhere a mate to it, a counterpart. To pardon the analogy, we might say that forces come into the world not singly but as twins, or still better, as Siamese twins, the difference being that while the surgeon's knife may conceivably separate a pair of Siamese twins and give each independent life no such operation can be performed on a pair of forces, except as an abstraction in our own minds. The reaction to a force must be understood to be literally one single force, not two or more forces. This law states that when a body A exerts a force on another body B, then B

exerts on A a force of equal magnitude in the opposite direction along the same straight line. To illustrate: suppose a clamp weighing ten pounds be suspended from two nails on the wall so that the weight is equally distributed. The reaction to the ten-pound force acting on the clamp are not the two five-pound forces which the nails exert on the clamp, but a single force of ten pounds acting on the earth at its center and directed toward the center of the clamp.

On External and Internal Forces.—Among the forces connected with a body we distinguish external or impressed forces, from stresses or internal forces. A force is said to act or to be impressed upon a body if its reaction is on a particle of matter which is not a part of the body, on a particle outside the body. It is said to be internal to the body if this reaction is on a particle which is a part of the body, on a particle within the body. To return to the illustration of the clamp suppose we now add that it has been tightened to produce a fifty-pound pressure. The external forces on the clamp would consist of the weight and the nail forces, while the fifty-pound pressure would constitute an internal force.

It is important to observe that the motion of a body is determined completely and solely by the external forces, for the internal forces appear on the body with their respective reactions, each cancelling the external effect of the other, thus making their net contribution to this motion nil. It follows that the equations of motion are written for the external forces only.

Let us now examine that concept of centrifugal force the discussion of which is the object of this paper. There is a widespread misconception that centrifugal force is an external force acting on all bodies having rotary motion, and that it contributes to this motion in the same manner as does the force of gravity, or a force due to a pull or a push. It is more often by implication in classroom work, than by actual misstatement in texts that this point of view is developed. Whatever its origin, its existence can not be denied. Year after year new classes of students in engineering mechanics supply fresh

clinical evidence of its existence. Nor is this attitude confined to students. Many instructors of college physics vigorously defend it. It seems even to be international in character, for reference to it can be found in English and German works. As an illustration of this point of view let us examine the conventional solution of the simple pendulum. In order to find the tension in the string holding the bob in the position of Fig. 1, the procedure is to show three forces on the block:

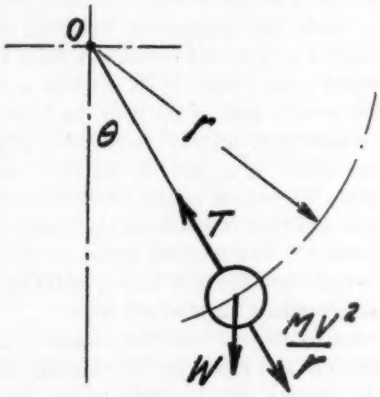


FIG. 1.

the weight, the tension in the string, and the mysterious Mv^2/r (the centrifugal force), and then to put the sum of the projections of these forces on the line of the string equal zero, thus

$$Mv^2/r + w\text{Cos}\,\theta - T = 0.$$

It is important to note that no distinction is here made between the centrifugal force and the other forces.

Several questions immediately arise in connection with this solution. First, where does the Mv^2/r come from? By what mechanism was it brought to act upon the body? Second, where is the reaction to this centrifugal force? Third, since the block is moving in a circle of finite radius with a velocity

greater than zero it has a normal acceleration v^2/r, which is not zero. By what right then do we put the sum of the forces equal zero in a direction where the acceleration is not zero? This is a direct violation of Newton's second law $F = Ma$, and this should be sufficient to convince anyone that this solution is wrong. In discussing this matter with physicists I found that where there still was a reluctance to recognize an error in the above point of view it was usually because this method gave the correct value for the tension in the string. Let us, therefore, apply this method to a somewhat more complicated problem. Consider a bar 4 ft. long, 4 lbs. in weight, and free to turn about a smooth pivot at one end as a compound pendulum. The bar is raised so that its axis is above the horizontal, and makes an angle of 30° with it. Assuming that the bar is released from this position the problem is to find the magnitude and direction of the reaction of the support after the bar has turned through 30°. Treating this problem in the

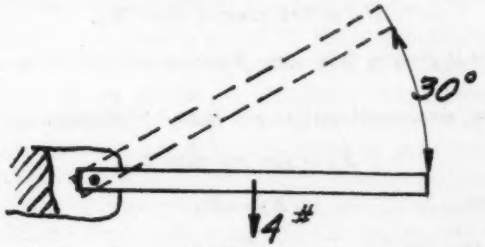


FIG. 2.

same way as the simple pendulum will result in an answer considerably different from the correct one. As a matter of fact the correct value of the tension in the simple pendulum was obtained accidentally. It may be accounted for by two compensating errors: the addition of a force where no force exists and the writing $\Sigma F = 0$ where it is not equal to zero.

We will now show that centrifugal force can not form a part of the system of external forces on the rotating body because there is no agent available to impress that force upon the body.

For this purpose we will prove a proposition which will enable us to determine whether a force is, or is not acting upon a body at any given point.

A Fundamental Proposition.

There are two ways only in which a force can be brought to act upon a body: one way is by means of physical contact of another body with it, the other way is by means of a field of force such as a gravitational field or a magnetic field.

The truth of this principle is almost self-evident. It can be rigorously proved, however, as follows:

Let N_F be the number of ways in which a force can be impressed upon a body.

Let N_A be the number of ways in which a body can be accelerated.

Since all forces, as we pointed out in our definition, cause accelerations

$$N_F \text{ is not greater than } N_A,$$

for were it greater then some forces would not cause acceleration.

Again, since accelerations are caused by forces only,

$$N_F \text{ is not less than } N_A.$$

Hence,

$$N_F = N_A.$$

The two sets of ways or methods are, therefore, equal numerically. But the cause of a force is also the cause of the ensuing acceleration. Therefore, the two sets of ways are not only equal in their numerical aspects, but also in substance. In other words, they are really one and the same set. It is thus possible to study the mechanism to impress forces by studying the mechanism by which accelerations are generated. It is worth while to illustrate this point. Suppose we had before us two tool chests F and A. Suppose further that chest F contained the tools by means of which forces can be impressed upon a body, while chest A contained the tools by means of which accelerations are generated.

Since accelerations are caused by forces only it follows that among the tools of chest *F* there will be found just such tools as in chest *A*. For were this not the case it would be possible to cause an acceleration with a tool which cannot cause a force, *i.e.*, there would be an acceleration without a force.

Again, since all forces cause acceleration, the tools in chest *F* contain no tool which is not also in chest *A*. For if it did, it would be possible to cause a force without causing an acceleration.

It therefore follows that the two chests contain identically the same sets of tools and the inspection of one reveals all about the other.

But since no body has ever been accelerated without either the physical contact of another body with it such as a pull or a push, or by subjecting it to a field of force such as gravitation or a magnetic field, it follows that no force can be brought to act upon a body without physical contact of another body with it or without the influence of a field of force.

We are now in a position to test for the existence of centrifugal force. To return to the illustration of the simple pendulum, Fig. 1. A glance at the body and surroundings reveals that there is no field of force in the direction of the centrifugal force, to which its life could be attributed. Its only birthright, then, is in physical contact of another body with it. But the only contact with the outside world the bob has, is with the string, and it can exert a tension only toward the center of the circle and not in the direction of the centrifugal force. Hence, centrifugal force, as an external force upon a rotating body simply does not exist.

The correct free-body diagram for the bob consists of the two forces only: the weight and the tension. There remains now to discuss centrifugal force from the point of view of D'Alembert's principle.

D'Alembert's principle states that the impressed forces on a body are in equilibrium with the reversed effective forces. Impressed forces have already been defined. We will now define effective forces for a particle as the system of forces

acting upon it when considered by itself. By the effective forces of a body we shall understand the sum of the effective forces of all the particles into which the body is for convenience broken up. To prove D'Alembert's principle it is necessary and sufficient to demonstrate that the impressed forces always equal the effective forces of the body, for obviously then the addition of the effective forces reversed would cancel the impressed forces, and the system would be in equilibrium. For the sake of simplicity let us consider a body acted on by co-planer forces only. See Fig. 3. Imagine this

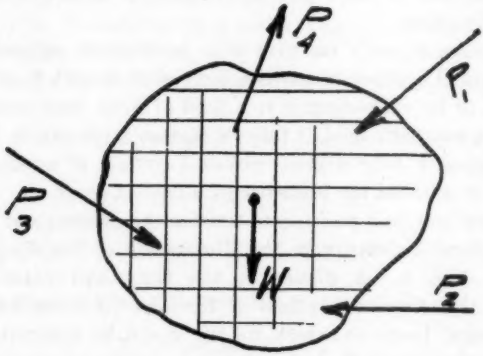


FIG. 3.

body split up into particles as shown. Consider now the particles separated and free-body diagrams made for each one. Fig. 4 shows a general free-body diagram. These diagrams will always contain the weight of the particle and the forces which the neighboring particles exert, the force between two particles being assumed to act along the line determined by the centers of the particles and to obey the law of action and reaction. In addition, some particles will carry the impressed forces P_1, P_2, etc. Our problem now is to find the resultant of all these effective forces. We proceed to add the forces along any vertical column. The forces marked by the same numbers would cancel out, that is the purely internal forces

would drop out. The same would evidently be true for all vertical columns and horizontal rows. The forces that would not cancel out would be the weights of the particles whose sum

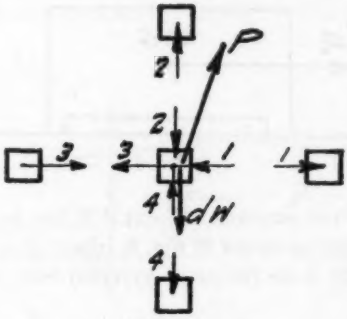


FIG. 4.

would equal the weight of the body and such impressed forces as P_1, P_2, etc. It is clear, then, that the resultant of all the effective forces equals the impressed forces upon the body, and thus the truth of D'Alembert's principle is established.

The significance of this principle is in the fact that it enables us to transform a problem in dynamics to an equivalent problem in statics. Before this principle was stated a simple problem in dynamics was a contest for great mathematicians, while relatively complicated problems in dynamics are now solved by students of engineering mechanics in their junior year.

To apply this principle to a particular problem it is necessary, however, to have complete information about the reversed effective forces, *i.e.*, their number, magnitude, direction and point of application, or, for short, the characteristics of the reversed effective forces. For the sake of brevity, we will state these characteristics without formal proof.

Case 1. Pure translation. The R.E.F. (reversed effective forces) consist of a single force equal Ma, acting at the center of gravity of the body in a direction parallel and op-

posite to the acceleration (Fig. 5), where M stands for the mass of the translating body and a for its acceleration.

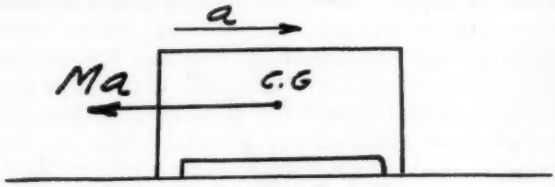


FIG. 5.

Case 2. Pure rotation. The R.E.F. can be represented by two forces such as shown in Fig. 6, where M is the mass of the rotating body, k its radius of gyration with respect to point

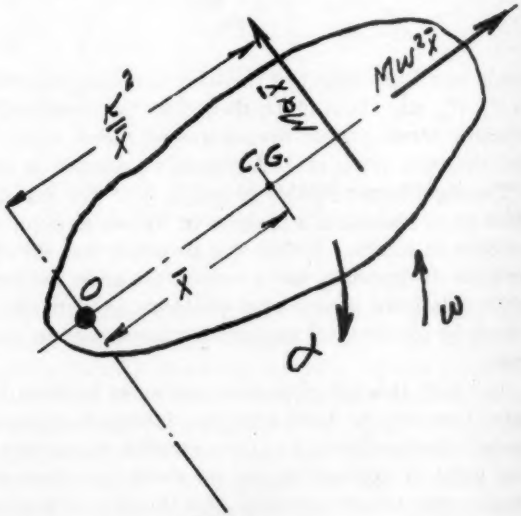


FIG. 6.

o, w and a angular velocity and acceleration respectively. For simplicity, o may be regarded as a fixed axis. The cen-

trifugal force Mw^2x is independent of the direction of the angular velocity while the Max is opposite to the angular acceleration.

Case 3. Plane motion. R.E.F. can be represented by three forces such as shown in Fig. 7. In Fig. 7 o is an arbitrary

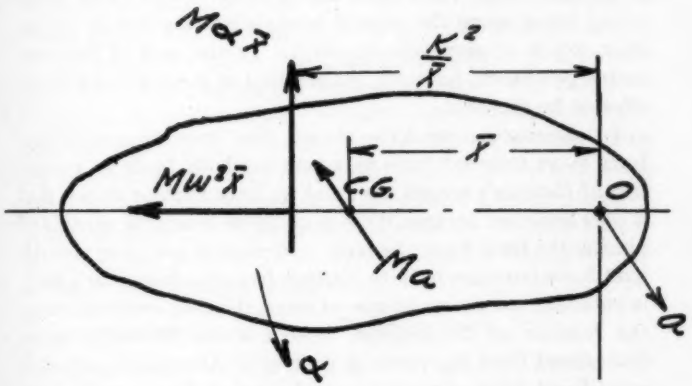


FIG. 7.

reference point whose acceleration is represented by a. The radius of gyration is with respect to the reference point is denoted by k. Here again, the centrifugal force is always away from the center of rotation regardless of the direction of the angular velocity, while the Max and the Ma are reversed with respect to the angular acceleration and that of the reference point respectively.

In order to find certain unknowns among the impressed forces we restore the body to equilibrium by the addition of the proper set of the R.E.F. In doing this, however, we must not lose sight of the fact that all this addition is convenient fiction; that in reality there are no such forces among the forces on the body.

It should now be possible to understand what happened in the solution of the simple pendulum. The addition of the centrifugal force and the subsequent writing of $\Sigma F = 0$ was

almost equivalent to the application of D'Alembert's principle. In a complete application of this principle the Max would also be added, this problem belonging to Case 2 of the three cases mentioned. That the correct value of the tension in the string was obtained without it is another bit of evidence of the accidental character of that solution. The stress in the string being along the normal is obviously unaffected by the Max, which is perpendicular to it. In the case of the compound pendulum, however, the reaction of the pin is decidedly effected by the Max.

To summarize, we have shown that treating centrifugal force as an external force on a rotating body leads to a violation of Newton's second law; and we have further shown that it does not exist because there is no agent available capable of placing the force upon the body. We might note that centrifugal force must not only be omitted from the forces on a body in rotation, but except in special cases, does not even represent the reaction of the support around which the body turns. Considered from the point of view of D'Alembert's principle centrifugal force is merely one of a set of forces which have to be added in the case of pure rotation or plane motion in order to restore the body to equilibrium. It has no greater claim to reality than the remaining forces in this method such as Max or Ma.

In introducing students to problems of rotation two courses can be followed: one is to explain D'Alembert's principle and use centrifugal force, the other method is to write the equations of motion for the impressed forces and abstain from centrifugal force even to the extent of its name. The latter method is in my estimation simpler for beginners, and results in less confusion and greater clearness of thought.

STANDARDIZATION OF SCIENTIFIC AND ENGINEERING SYMBOLS AND ABBREVIATIONS.

As you know, the S. P. E. E. is Sponsor in American Engineering Standards Project Z–10 for the Standardization of Scientific and Engineering Symbols and Abbreviations.

The various Technical Sub-Committees have been appointed and are at work on various lists of symbols. The first Sub-Committee to report is the Committee on Mathematical Symbols, and this report is now before the Sectional Committee on the Project for vote for proposal to the A. E. S. C. Main Committee as an American Society. It seems to me desirable that this be published in ENGINEERING EDUCATION, in order to create discussion, and I have the approval of the various officials of the Project for such publication.

TO MEMBERS OF THE SECTIONAL COMMITTEE:

Our Subcommittee on Mathematical Symbols having completed its immediate task, and having considered all conflicts and duplications of symbols which we have been able to communicate to them as arising out of the work of the other Subcommittees, has approved the attached draft of material proposed for adoption as an American Standard. The personnel of the Subcommittee is as follows:

E. V. Huntington, Chairman, American Mathematical Society, Harvard University,

R. M. Anderson, Society of Automotive Engrs., Stevens Institute of Technology,

V. Bush, American Institute of Electrical Engineers, Massachusetts Institute of Technology,

R. M. Foster, Bell Telephone System,

E. R. Hedrick, Mathematical Association of America, University of California,

A. E. Kennelly, Institute of Radio Engineers, Harvard University,

W. D. Lambert, U. S. Coast and Geodetic Survey,
E. J. Miles, Society for the Promotion of Engineering Education, Yale University,
H. B. Reynolds, The American Society of Mechanical Engineers, Interborough Rapid Transit Co.
Chester Snow, Bureau of Standards,
A. Cohen, American Mathematical Society, Johns Hopkins University,
O. Veblen, American Mathematical Society, Princeton University,
V. S. von Szeliski, American Statistical Assn.
A. P. Wills, American Physical Society, Columbia University.

Draft of this subcommittee report was considered at the meeting of your Executive Committee, January 22d, 1927, and approved with slight amendments which have been introduced into the attached report.

This list of Mathematical Symbols is therefore submitted to members of the Sectional Committee with letter ballots upon which members are requested to act promptly. If approved by the Sectional Committee, this material will be sent to our five sponsor bodies for approval and conveyed to the Main Committee of the American Engineering Standards Committee for final action.

Respectfully submitted,
PRESTON S. MILLAR,
Secretary Sectional Committee.

ARITHMETIC AND ALGEBRA

1.1. $= \neq + - \pm \mp <> \leqq \geqq ( ) [ ] \% \infty \approx$ (for approximately equal to).

1.2. $a \times b = a \cdot b = ab$; $a \div b = a/b = \frac{a}{b}$. (Influence extends to next + or −.) Thus, $a - b/c - d$ should not be used for $(a - b)/(c - d)$. Note that $\frac{a}{b}$ is difficult to print in running text.

1.3. $a/b = c/d$ for proportion. Discourage $a : b :: c : d$.

1.4. Notation by powers of 10 for very large or very small numbers is recommended; as 3.140×10^{3} and 3.140×10^{-2}. The notation $0.0^{5}314$ is useful in tables, to indicate that there are five zeroes after the decimal point.

1.5. In writing numbers having a large number of digits, half-spaces instead of commas should be used to separate groups of digits. In writing decimals, the 0 before the decimal point should not be omitted (except in tables).

1.6. $|x|$ = absolute value of x. $x! = 1 \cdot 2 \cdot 3 \cdots x$. Discourage $\underline{x}$.

1.7. $\sqrt{x} = +\sqrt{x}$, not $\pm\sqrt{x}$ (x being real and positive). $a^{1/n} = \sqrt[n]{a}$. $a^{-n} = 1/a^{n}$. $\exp x = e^{x}$ is useful when x is a complicated expression. Note that the bar or vinculum after the $\sqrt{}$ is very expensive to print.

1.8. When $\log x$ is ambiguous, use $\log_{10} x$ or $\log_{e} x$. The notation $\ln x$ may be mentioned as an alternative for $\log_{e} x$.

1.9. $P(n, r) = n(n-1)(n-2) \cdots (n-r+1)$. $C(n, r) = [n(n-1)(n-2) \cdots (n-r+1)]/[1 \cdot 2 \cdot 3 \cdots r]$ = binomial coefficients. A common alternative for $C(n, r)$ is $\left(\frac{n}{r}\right)$; this, however, is difficult to print in running text.

1.10. $a \propto b$ (meaning a varies directly as b).

Elementary Geometry

2.1. $\angle$ $\triangle$ $\parallel$ $\perp$ $\odot$ $\angle\!\!\square$ $\therefore$

Analytic Geometry

3.1. x, y, z; ξ, η, ζ; rectangular coordinates. Right-handed system preferred.

3.2. ρ, s = intrinsic coordinates. ρ = radius of curvature, s = length of arc.

3.3. $l = \cos\alpha$, $m = \cos\beta$, $n = \cos\gamma$, direction cosines.

3.4. r, θ = polar coordinates. ψ = angle from radius vector to tangent.

3.5. r, θ, ϕ = spherical coordinates. θ = co-latitude, ϕ = longitude. (Usage general in mathematical physics; other notations are used in astronomy.)

3.6. r, θ, z = cylindrical coordinates. (Usage diverse.)

3.7. Conics: e = eccentricity. p = semi-latus rectum (usage general in U. S.).

3.8. Straight line: $y = mx + b$.

Trigonometric and Hyperbolic Functions

4.1. ° ′ ″ $\sin x$, $\cos x$, $\tan x$, $\operatorname{ctn} x$, $\sec x$, $\csc x$.

4.2. $\sin^{-1} x$ = the principal value of the angle whose sine is x (when x is real). Thus, $-\pi/2 \leqq \sin^{-1} x \leqq \pi/2$, $0 \leqq \cos^{-1} x \leqq \pi$, $-\pi/2 \leqq \tan^{-1} x \leqq \pi/2$. (Discourage arc sin x.)

4.3. $\sin^2 x$ for $(\sin x)^2$ is an exceptional notation, justified by usage.

4.4. $\sinh x$, $\cosh x$, $\tanh x$, $\operatorname{ctnh} x$, $\operatorname{sech} x$, $\operatorname{csch} x$.

4.5. $\cosh^{-1} x$ = the principal value (when x is real). (Discourage arc sinh x.)

4.6. $\sinh^2 x$ for $(\sinh x)^2$ is an exceptional notation, justified by usage.

4.7. In general f^{-1} means the inverse of the function f; while f^2 denotes iteration of the functional operation. But in exceptional cases, f^2 may denote the square of the function f (as in $\sin^2 x$ and $\sinh^2 x$). In general, $[f(x)]^{-1} = 1/f(x)$.

Calculus.

5.1. If $y = f(x)$, derivative $= y' = f'(x) = \dfrac{dy}{dx} = D_x y$. Second derivative $= y'' = f''(x) = \dfrac{d(y')}{dx} = D_x^2 y = \dfrac{d^2y}{dx^2}$. Note $\dfrac{d^2y}{dx^2}$ cannot be regarded as a fraction, except when x is the independent variable; in general, $\dfrac{d^2}{dx^2} = D_x^2$ = a symbol of operation on y.

5.2. If $u = f(x, y)$, partial derivative $= u_x = f_x(x, y) = D_x u = \dfrac{\partial u}{\partial x}$. Similarly, $u_{xy} = f_{xy}(x, y) = D_y(D_x u) = \dfrac{\partial^2 u}{\partial y \partial x}$.

Note. $\frac{\partial^2 u}{\partial y \partial x}$ and $\frac{\partial u}{\partial x}$ are not fractions; $\frac{\partial}{\partial x} = D_x$ and $\frac{\partial^2}{\partial y \partial x} = D_y D_x$ are symbols of operation.

5.3. Δy = increment, dy = differential. δy = variation. $\sum_{i=a}^{b}$ = summation.

5.4. $\dot{x} = dx/dt = v$; $\ddot{x} = dv/dt$ (used only for differentiation with respect to the time t, and difficult to print).

5.5. $\lim_{x \to a} (y) = b$; $y \to b$ as $x \to a$. (Discourage $\doteq$.)

5.6. $\int_a^b f(x)dx$. $F(x)|_a^b = F(b) - F(a)$. $\int\int f(x)dxdy = \int[\int f(x, y)dx]dy$.

5.7. $\pi = 3.1416 \cdots$ $e = 2.718 \cdots$ $i = \sqrt{-1}$ (in pure mathematics).

5.8. If $z = x + iy$, then $|z|$ = absolute value, or magnitude, $\angle z$ = angle, $R(z)$ and $I(z)$ = real and imaginary parts, $\bar{z}$ = conjugate of z. (Where $\bar{z}$ is difficult to print, use conj. z.)

Special Functions.

6.1. Bessel Functions. The notation used in G. N. Watson's Treatise, 1922, as endorsed by E. P. Adams in the Smithsonian tables, 1922, is recommended.

6.2. Bernoulli numbers. Of the five or six different notations in use, the notation B_1, B_3, B_5, $\cdots$ has historical priority and many practical advantages, but the notation B_1, B_2, B_3, $\cdots$ is the one most used in recent years. To indicate what usage is being followed, authors will do well to state explicitly the value of the first few numbers, as $B_1 = 1/6$, $B_2 = 1/30$, $B_1 = 1/42$, $\cdots$.

6.3. $\gamma = 0.5772 \cdots$. (Euler's constant.)

Vector Analysis.

7.1. Vectors to be indicated in printed matter by letters in bold face type, and in written manuscript by letters modified by a bar above (or by the doubling of some part of the character). The magnitude of a vector to

be indicated in print by the corresponding italic letter, and in manuscript (when necessary) by the use of the absolute value signs, | |.

7.2. The scalar product, or dot product, $= a \cdot b$, the dot being centered. (Other notations are Sab, or (ab) in round parentheses.)

7.3. The vector product, or cross product, $= a \times b$, the cross being small. (Other notations are Vab, or $[ab]$ in square brackets.)

7.4. i, j, k = unit vectors along the axes (right-handed system).

7.5. As to further questions of notation in Vector Analysis (including Tensor Analysis), the Subcommittee recognizes the desirability of a thorough-going attempt to bring uniformity out of the present diversity of usage, but recommends the appointment of a special committee to take up this subject.

ABBREVIATIONS.

8.1. It is desirable to distinguish between (1) a "symbol," that is, a single letter or a single letter affected with subscripts, etc., which is to be used to represent a numerical value in a formula; and (2) an "abbreviation," which may consist of several letters, but is not intended to be substituted for a numerical quantity in a formula.

8.2. Standard abbreviations such as ft/sec^2, ft-lb/min, etc., should not be further condensed, lest clearness be sacrificed to brevity.

Note: The recommendations concerning terms and symbols in elementary mathematics contained in Chapter 8, pages 74–85 of the Report on the Re-organization of Mathematics in Secondary Education, made in 1923 by the National Committee on Mathematical Requirements (under the auspices of the Mathematical Association of America), were, with one or two unimportant exceptions, endorsed by the Subcommittee.

REPORT OF COMMITTEE NO. 6, SECTIONS AND BRANCHES, FOR THE YEAR 1926–1927.

The Committee on Sections and Branches respectfully submits the following report dealing with its activities during the present session.

The Committee on Committees decided to place the activities of the Committee on Sections and Branches in the hands of the Second Vice-President, definite knowledge of this action reaching the present Chairman on receipt of the December number of ENGINEERING EDUCATION. As a consequence of this situation really active work for the year was undertaken in January. Furthermore, it was decided to make the matter one involving but a single individual, the Chairman.

In preparation for the work of the session a considerable time was spent in studying the status of Section and Branch organization in past years. An outline of a proposed program of activity was then drawn up and a careful study of the entire group of 150 institutions in the United States which award degrees in engineering was made. This study was particularly made in order to discover the most logical groups, not now enjoying Section activity, to insure as nearly as possible the perfection of a campaign which in time would bring every institution, as far as possible, into a group or Section relation.

This study resulted in fixing the geographical relations of all the institutions, from which data the most promising and logical groupings with respect to contiguity were scheduled. In February this material was in such shape as to warrant a start of active correspondence. Individual letters were addressed to a chosen person in each of the 150 institutions, letter content being modified in every case to best fit the individual aspect presented by such considerations as number of Society members, past Branch or Section activity, and such other elements as might prove relevant in each case.

It was decided that in addition to a discussion of the special matters of Branch and Section work it would not be amiss to stress the subject of increased individual membership in the Society. The appeal was in consequence a triple one. First attention was directed to membership increase involving three distinct groups of potential members, teachers of young engineers, practitioners, and representatives of preparatory agencies of various kinds and grades. A plea was then presented for earnest consideration of Branch formation, and finally definite allocated groups of institutions seemingly offering some possibility of Section formation were outlined with a request that the complete group of suggestions be studied and if feasible made objects of definite action. In closing the appeal it was requested or rather indicated that a reply would be greatly appreciated from each institution addressed at the early convenience of the respective parties addressed.

The initial correspondence was completed before April first and to May fifteenth replies have been received from 64 different institutions, or approximately 43 per cent of those addressed. The first reaction was in the nature of disappointment at the small return, followed quickly, however, by a more optimistic feeling produced by a review of the communications received, a considerable number having brought about several exchanges of letters dealing with a variety of interesting reactions.

The exact and tangible results of this campaign cannot be accurately stated at present due to the inevitable time-lag in matters of this character. However, the partial returns are not without promise in several respects.

First: A fairly definite increase in membership may be undoubtedly traced back to the influence of this correspondence, and it seems equally certain that additions will continue to be recorded for some months yet.

Second: It is very evident from the returns so far that there is little or no enthusiasm toward the inauguration of new Branches. This attitude is in general quite easy to under-

stand and should not be interpreted as indicative of a lack of interest or of real activity in institutions responding. Many of them are practically obtaining the results of organized Branches by means of a variety of local committee and group meetings held frequently for the express purpose of studying and discussing matters of educational policy. In this way a commendably large number of faculties are busied with such problems as seem most urgent in each locality.

Third: Although at this time it is not possible to report the actual formation of a new Section as a result of the campaign, yet the whole situation regarding increased Section activity in the immediate future proves quite promising. Reports already received assure the formation of two additional small Sections within a few months. In addition, the outlook is undoubtedly promising for two more rather larger Sections and for the expansion of three existing Sections to embrace one or more near-by institutions. If a vigorous follow-up program is adopted it appears quite within reason to expect several further additions to the family of Sections in the course of another year.

The outstanding event in the field of Section activity during the year was the formation of the Greater New York-Northern New Jersey Section, organized in January and now enthusiastically at work. This Section was brought into being wholly upon the initiative of the members in the territory covered and served as a welcome incentive for the efforts of this committee.

A perusal of the JOURNAL for the current year discloses a sparcity of reports of Section and Branch activity which might readily lead the reader to an erroneous conclusion respecting the real situation as it exists in our institutions. In the JOURNAL, from September, 1926, to April, 1927, there appear reports of meetings during the session from the New England, the Kansas-Nebraska, the Minnesota and the Greater New York-Northern New Jersey Sections, the Purdue and Colorado Branches. This material does not indicate the very considerable activity of the Ohio Section, the Ohio State,

Texas A. and M. College, and Maine Branches which have been disclosed from the committee correspondence. A glance at the constitution shows that such a situation is in direct opposition to the provision whereby Branch and Section secretaries are instructed to report proceedings of their respective groups. For a number of reasons which it seems unnecessary to mention, aside from the constitutional factor, it is earnestly urged that hereafter secretaries of organized Branches and Sections report on meetings held so that the membership at large may be properly informed regarding the activities of these groups. In addition, it would be very enlightening also if those unorganized groups, closely fulfilling the functions of Branches, would likewise make it a practice to report their deliberations for publication.

If returns were obtained from those institutions as yet silent regarding this campaign, it is reasonable to suppose that evidence of many more group meetings would be furnished. It is to be hoped that the coming years will witness a most decided expansion of the portion of the JOURNAL assigned to Sections and Branches as more and more institutions gather momentum which is bound to follow the rapidly expanding activities of the Society as a whole.

The growth of Sections in new territory is rather naturally a somewhat slow process, requiring steady and effective efforts in order to bring about the widest possible activity. Meager as the results of this year's efforts appear at first glance, the outlook is fraught with a considerable degree of promise for the future. Much of the indefiniteness now present would be cleared up by a more nearly complete response from the institutions addressed. Present lack of data need not be looked upon as indicating a lack of interest or of appreciation, but rather may be explained upon other grounds such as might be expected in a group of busy people confronted by such multitudes of demands as are our members. It is particularly urged in closing this report that such recipients of the Committee's correspondence as have not yet replied, and whose

attention may be directed to this report, will, at their earliest opportunity, make it a point to help in completing this survey to the extent of sending their reactions to the Chairman.

Respectfully submitted,

W. S. RODMAN,
Chairman,
Com. on Sections and Branches.

THE CONFERENCES ON ENGLISH.

This is, of course, the very last call for the conferences on English. Everyone in the engineering colleges who is interested in the teaching of English to engineering students must surely know by this time that in connection with the annual meeting of the Society for the Promotion of Engineering Education, at the University of Maine, Orono, Maine, this year, there will be held three conferences, at which our mutual problems will be discussed.

At ten o'clock Monday morning, June 27th, at Aubert Hall, the Division of Deans, Administrative Officers, and Teachers of English will hold a joint conference at which "The Teacher of English in the Engineering College" will be considered. At nine-thirty on Wednesday, June 29th, in the Arts and Science Building, the Teachers of English and others interested will discuss the subject "Making English an Integral Part of the Engineering Curriculum." At this time, Miss Harbarger, of Ohio State, will also present the report on her study of freshman composition in the engineering colleges, on which she has been engaged for some time. Dr. John M. Clapp, Chairman of the Committee on the Bureau of Language Research of the National Council of Teachers of English, will present, briefly, the Institute of Communication, which is proposed as a project of this Committee. At noon on Tuesday the Teachers of English will hold an informal luncheon conference.

As usual, the Committee on English, three members of which will be present at the conferences, will be very glad to confer during the entire week at any available time with anyone interested in discussing individual problems which may concern them in the administration of this work.

Communications regarding the conferences may be sent to the Chairman of the Committee on English, J. Raleigh Nelson, 927 Forest Ave., Ann Arbor, Michigan.

SECTIONS AND BRANCHES.

A joint dinner meeting of the American Society of Mechanical Engineers, The American Society of Civil Engineers, The American Institute of Electrical Engineers, the North Central Electric Association and Minnesota Section of the Society for the Promotion of Engineering Education was held on Tuesday, April 5th, at the Nicollet Hotel, Minneapolis. Mr. C. J. Snyder, President of the North Central Electric Association, presided at the meeting. Mr. W. H. Meese, Operating Superintendent of the Western Electric Company, spoke to the combined groups on "Engineering Education from the Standpoint of the Employer" and Dean O. M. Leland discussed "Engineering Education from the Standpoint of the Educator." The talks were followed by discussions in which many men in the industries took part.

G. B. HEISIG,
Secretary.

The final meeting of the **Minnesota Section** of the S. P. E. E. for the academic year 1926–27 was held May 10th, at 5:45 in the Campus Club. The Nominating Committee reported the following nominees:

President: F. W. SPRINGER
Secretary: W. H. RICHARDS
Chairman of the Program Committee: G. B. HEISIG.

The Secretary was instructed to case a unanimous ballot for the nominees.

Mr. O. W. Potter, Manager of the Winona Machinery and Foundry Co., then addressed the meeting on the "Contribution to Engineering Education and Progress by the Foundry Industry." The address was followed by a lively discussion.

About 35 members and friends were present.

G. B. HEISIG,
Secretary.

Greater New York and Northern New Jersey Section of the Society for the Promotion of Engineering Education.—The second meeting of the N. Y.-N. J. Section of the S. P. E. E. occurred at Princeton on Saturday, May 14, 1927.

A few enthusiasts gathered at Princeton in the forenoon and successfully completed 18 holes of Golf on the Princeton course although no reports have yet been received that the course record was broken.

Dean Pegram, President of the Section called the afternoon meeting to order at 3 P.M. with about 75 members in attendance. President Hibben, of Princeton, welcomed the members on behalf of the University, expressing his interest in and admiration for the work of engineers. The program proved to be unusually attractive and although several of the papers were apparently unique for an engineering society program, yet they were all stimulating and of real value to teachers of engineering. The time from 5 to 6:30 P.M. was profitably spent in visiting the points of historic and educational interest on the Princeton campus, including the famous graduate school with its Cleveland Tower, Refectory, and the living and recreation rooms for graduate students, the new Gothic Chapel by Ralph Adams Cram, now in process of construction and not by any means least in interest, old Nassau Hall where the Continental Congress once held its sessions.

64 persons sat down to dinner in Madison Hall at 6:30 P.M. as the guests of the University. Dr. Alex. Humphreys, President of Stevens Institute, was to have been the Guest of Honor of the Section at the dinner, but he was prevented from attending by illness, a matter of extreme regret to all those present. Dean Bishop, Secretary of the National Society came on from Pittsburgh and as a most distinguished guest was called on for a few words.

The Section endeavors to make social and educational features the prominent part of its meetings, but a short business meeting disposed of what little business was necessary. This included a vote of thanks to Princeton University, to President Hibben, and to Dean Greene for the numerous courtesies ex-

tended to the Section and the arrangements for the next meeting; also included a vote to send a letter to Dr. Humphreys expressing the regret of the Section that he was unable to be present. The members then adjourned to the Freshman Commons where Prof. Edward Capps, L.H.D., gave an inspiring talk on Archeology in Greece. Prof. Capps has had long experience in Archeological exploration in Greece and is now planning to leave very shortly to resume his work of excavation in Athens.

Plans for the Section contemplate several meetings each year with the probability that the next one will occur at New York University late in October, 1927.

The complete program was as follows:

Morning Meeting—Golf—10:00 A.M.

Afternoon Meeting—3:00 P.M.

Word of Welcome, President Hibben.

Report on Progress and Future Plans of the S. P. E. E. Investigation, Prof. Hammond.

Study of the Princeton Admission System, Prof. C. C. Brigham, of Princeton University.

The Teaching of Economics by the Case Method, Prof. Wm. E. Weld, Columbia University.

The Work of the Exceptionally Gifted Student, Prof. John C. Olsen, of Brooklyn Polytechnic Institute.

The Place of Technical Institutes in the Field of Engineering Education, Director S. S. Edmands, Pratt Institute.

Social Meanderings about the University, 4:30 to 6:00 P.M.

Dinner at 6:30 P.M. in Madison Hall, Guest of Honor, President Alexander C. Humphreys, of Stevens Institute. (Due to illness Pres. Humphreys was unable to attend.)

Short Business Meeting and Address by Prof. Edward Capps, L.H.D., Professor of Classics, Princeton University, "Archeology in Greece." Freshman Commons.

EDWARD H. ROCKWELL,
Secretary.

Ohio Section.—Eighteen delegates from eight Ohio colleges—Case, Ohio Northern, Akron, Ohio State, Wittenberg, Dayton, Antioch, and Cincinnati—members of the Ohio State University Branch and Associate Director Hammond, met in Columbus, February 19th, to discuss college entrance problems, educational guidance and publicity for secondary school students. While this was primarily a meeting of delegates, great interest was shown locally by the Faculty of the College of Engineering, Ohio State, so that the total attendance was forty.

The program follows:

Address of Welcome, President G. W. Rightmire, Ohio State University.

Opening of the Discussions, Professor H. P. Hammond, Associate Director of Investigation.

Address on Entrance Problems, Professor E. E. Lewis, Department of School Administration, Ohio State University. .

Selective Admission. Discussion opened by Professor A. C. Swinneston, Antioch College, Professor F. M. Comstock, Case School of Applied Science.

Educational Guidance and Publicity for Secondary School Students. Discussion opened by Dean T. M. Focke, Case School of Applied Science, Professor H. B. Luther, University of Cincinnati.

The Junior College. Discussion opened by Professor W. T. Magruder, Ohio State University.

The Freshman Plan. Discussion opened by Dean F. E. Ayer, University of Akron, Professor Robert Meiklejohn, Ohio State University.

President Rightmire, in his *Address of Welcome*, commented upon the need of a reappraisal of educational values and practices as an aid to a new orientation. In connection with engineering education, there are four important questions to be considered:

1. The amount of general basic subjects in the various curricula.

2. The amount of technical.
3. The amount of cultural, that is of the social sciences.
4. The opportunity for study of citizenship.

Students can enroll in some colleges in the university, carry a full curriculum and graduate without ever coming into contact with any courses in social science, sociology, history, or any other of the social courses. "No one," in President Rightmire's opinion, "should receive a university degree without having some of the courses or subjects which go to make for citizenship after he leaves college. The criticism of college students today can be traced to their lack of knowledge of the so-called social sciences."

Associate Director Hammond pointed out that the diversity of conditions in Ohio, in which there is every type of engineering school and a full range of urban, suburban and rural high schools, gives an unusual opportunity for a study of all the different problems. He opened the discussions by reporting progress on the investigation and listed the projects now under consideration. In commenting upon admissions, he sketched the present situation as revealed by the investigation. While the high schools are better organized than ever before, the emphasis in the secondary school work has been toward social training instead of intellectual to such an extent, in fact, that there are many "sight-seeing" courses. There is an increasing percentage of elimination of students in colleges and the question arises as to the best means of selecting students for engineering colleges. Any selective process must proceed slowly, however, for there are many aspects to be considered, but grades in algebra seem to be the one best index.

Professor E. E. Lewis, in his *Address on Entrance Problems*, said that the power of the high school to hold pupils is increasing and that the enormous wealth and the enormous faith of the American people in education will still further increase high school attendance. There should be scientific exploration in population studies to discover how many students will have to be educated and how much it will cost. In relation to admission to college, there are the two questions:

1. Who shall be admitted? 2. What shall be done afterwards? There are several possible plans for admission—arbitrary limitation which offers no solution; increasing fees, a method which, where it has been tried, has had no lasting effect; entrance examinations; uniformity of entrances and credits; selective admission; the junior college. After admission consideration must be given the basic curricula.

Antioch, in making a study of selective admission, has been confronted with the problem of rating students on intelligence tests and has found that the results show some lack of correlation between capacity and achievement. The most disturbing fact is the lack of stability on the part of students with high ratings and the diminishing ratio between capacity and achievement. Case has tried various methods of admission, among which were increased fees and entrance examinations. But increased fees lowered enrollment for only a few years. Entrance examinations were tried for six years. Case, however, has returned to the certificate method of admission and now accepts the upper two thirds of a high school class on certificate. The lower one third is privileged to take entrance examinations on recommendation of the high school principal. Fifty-five per cent of those admitted on certificate graduate and sixty per cent of those admitted on examination. The intelligence test is favored. Akron has the high school psychological test, but the four years' experience at Akron with selective admission has not been satisfactory. This year at Akron, an eight-weeks' summer school for those proposing to enter in the fall is to be tried. The consensus of opinion of the delegates seemed to be that the conference cases of admission were more frequently successful than any other.

Concerning educational guidance and publicity for secondary school students, the opinion seemed to be that much was yet to be done. It was suggested that a system of visitors to high schools in Ohio be undertaken by S. P. E. E. members and that definite steps be taken to have joint meetings of S. P. E. E. and high schools representatives from thoroughly organized groups. On the subject of the Junior

College, opinion varied. Differentiation should be made between a trade school and the Junior College. The Junior College is to be regarded as a feeder for the professional school and would make the transition between high school and college less confusing and less disconcerting. Experience with the Junior College has not, however, been sufficient to arrive at any definite conclusion. It was also pointed out that the Junior College would mean a five-year course. The four-year course is, however, the normal and proper thing and the general idea. The work in the Junior College should be the first year of the college course offered anywhere and equal to that offered at the institution to which the student goes for his last years. From an educational point of view, legislation is needed to permit boards of education in cities of certain size to establish junior colleges by subsidy and by tuition, that is, the working out of a statewide policy. Some form of intermediate school is desirable, but as yet there is little demand. The Freshman Week Plan is being tried out in Ohio. It has proved helpful in Akron. It is to be tried in Ohio State this fall.

The Spring Meeting of the Ohio Section, on the invitation of Dean F. E. Ayer, will be held at the University of Akron, the afternoon of May 13th, and the morning of May 14th. A great deal of interest has been displayed in the report of the Committee on Investigation and the problems which still confront them in their study of engineering education.

S. A. HARBARGER, *Secretary,*
Ohio Section.

COLLEGE NOTES.

Iowa State College.—Graduate courses in Civil, Electrical, and Mechanical Engineering are being offered at Iowa State College, Ames, Iowa. The summer session runs for eleven weeks beginning June 13th. Minor work in Mathematics, Physics, and Education are also given. These courses are attracting the younger teachers of Engineering from the middle west, mountain and coast colleges and universities. Anson Marston is the Dean of Engineering.